Characterizing collaboration through online interactions within R D communities

Marie Fraslin, Eric Blanco

ICED13
INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED13
19-22 AUGUST 2013, SUNGKYUNKWAN UNIVERSITY, SEOUL, KOREA

CHARACTERIZING COLLABORATION THROUGH ONLINE INTERACTIONS WITHIN R&D COMMUNITIES.

Marie FRASLIN, Eric BLANCO
Grenoble-INP, France

ABSTRACT

In global organisation, collaboration within distributed team is a crucial issue. Many companies are organizing communities of practice to improve experience sharing. These communities are mediated by collaborative platforms. Among collaborative functionalities, forum are expected to support distant asynchronous collaboration. But few studies show the effectiveness of this tool to support effective collaboration in the context of engineering design activity.
The paper study the interactions through forums of two Virtual communities of practices of experts within R&D teams of international company. A coding scheme is proposed to analyze and characterize the online interactions. Through these two case studies, we demonstrate that a forum can support asynchronous argumentative activities and thus enhance global collaboration in distributed R&D organizations. The proposed characterization of collaboration can be a step to dynamic evaluation team interaction.

Keywords: global R&D, virtual community of practices, collaboration, forum, online interaction

Contact:
Dr. Eric Blanco
Grenoble Institute of Technology
Engineering and Management
Grenoble
38031
France
eric.blanco@grenoble-inp.fr

1 INTRODUCTION

The globalisation has a huge impact on R&D activity and especially on the Product development activity. Large companies face new challenges and dilemmas in organizing R&D. Usually, the roles have been distributed between Research and Development teams (Von Zedtwitz, Gassmann et al. 2004). On one hand, research teams are in charge of developing new knowledge, technologies, concept and innovation, and on the other hand, the development teams are in charge of meeting market requirements by managing product development. This new form of organisation has changed the communication needs and therefore the requirements for communication tools. Many companies are leveraging collaborative platforms to facilitate this distributed design work.

A Collaborative Platform (CP) is a database of interactive web pages that allows members of a user group to collectively edit the same material from nearly any computer with an internet connection. The main purpose of a collaborative platform is to provide an easily accessible platform for recording and sharing information in a single location. With this interactive exchange, "*members can collaborate on content, either in real time or asynchronously, by editing the same document (or documents)"* (Girard and Fallery 2009). Among the technologies available in collaborative platform, functionalities of Forum are often used. Besides proving attractive to corporations, forums also provide researchers with the opportunity to record and analyse the complex and nuanced interactions of global virtual communities (Ioro, Peschiera et al. 2011). Few empirical studies on collaborative platform set up for Product Development team exist (Gardoni and Blanco 2003, 2005). Most of the studies have been carried out in education field and most of the empirical observations are related to student practices (Ioro, Peschiera et al. 2011) or in open innovation platform (Paulini, Murty et al. 2011).

In the study presented in this paper, we have analysed the content of interaction of two R&D virtual communities of practices of a multinational company. Following Porter (2004), a virtual community or e-community is defined as "*an aggregation of individuals or business partners who interact around a shared interest, where the interaction is at least partially supported and/or mediated by technology and guided by some protocols or norms*".

We proposed a coding scheme that allows demonstrating that a collaborative platform such as a forum supports asynchronous argumentative activities and thus enhance global collaboration and knowledge sharing in distributed R&D organizations.

2 INTERACTION CONCEPT CLARIFICATION

2.1 Interaction, a Key element of Knowledge Sharing

Kerbrat-Orecchioni (2005) identifies interaction when "*the discourse is caught in an exchange circuit: it is for a specific targeted population (whether individual or collective), endowed with the ability to speak in turn* ". Only the dialogue is equivalent to an interaction. Indeed, the interaction "implies that the recipient is able to influence and alter the behavior of the speaker of unexpectedly while he is engaged in the construction of his speech.

Professor Shigehisa Tsuchiya (1993) explains that dialogue is what permits the exchange and mediation of knowledge. He also concludes that to reach an exchange it is necessary that the interpretation schemes of each of the members of the organization possess a minimum of common representation which he calls 'commensurability'. The 'commensurability' of organization members' schemas of interpretation is indispensible in the sharing of individual knowledge. We translate from a French initial version and paraphrase his thoughts here: "*Individual knowledge is shared by way of dialogue. As knowledge is above all tacit, it has to first be articulated, and expressed in language in a general sense... It is important to clearly distinguish the sharing of information and the sharing of knowledge. Information does not become knowledge except for where it is understood by the schema of interpretation of the receiver who in turn gives it meaning. In most cases, any information inconsistant with this schema of interpretation goes unregarded.*"

Following this idea, Osterman et Kottkamp (2004) explain that the information become progressively knowledge by the receivers when they start to « *ask questions, challenge ideas, and process learning verbally, they clarify their thinking and deepen understanding* » (p. 20). However, it is now understood that for being able to ask a question, the interlocutor have to share commensurability', that means that the topic under discussion make sense in his mind. Jung and Latchem (2011) underline that " *dialogue in the form of teacher-student and student-student interaction tests and negotiates ideas,*

verifies learning, provides feedback, and constructs and expands knowledge and understanding" (p. 10).

The idea is that the conversation allows "*the deconstruction of those experiences and the reconstruction of a shared meaning in a way that transforms understandings and changes practice*" (Crow J. and Smith L. 2005). Christian Brassac (2000) claims that the co-construction of meaning is done thanks to the interaction: "*The interaction is not a message transfer exercise even implicit; the conversation is a meeting between cognitions involved*".

This is inscribed in the cognitive approach and its sense-making perspective with the assumption that the meaning creation come from the interaction between a man and its environment. Knowledge is situated in a contingent context in which human action and interaction takes place (Patriotta 2003).

In Engineering Design, Prudhomme, Pourroy and Lund (2009), inspired by teaching research, explains that knowledge emerges thanks to the personal connection that will build the individual with "the object of knowledge" in a given context. The object can be both tangible (a component, a machine) and symbolic (a formula of words, a graph). The meaning of the information that the individual will build will depend on a given context and individual intrinsic factors. This meaning is dynamic and will evolve to climb or not to the level of new knowledge in the heads of the individual. Learning will be measurable by the changes in the link that the person will meet with the object of knowledge manipulated.

According to Prudhomme and Pourroy observing a collaborative design situation that regroups designers with different and complementary expertise can allow researcher to observe knowledge sharing phenomena and learning phenomena. For them, a collaborative design situation leads to the confrontation of viewpoints and is thus a favourable ground for argumentation. They define argumentation between designers during the collaborative design of an industrial product as the cognitive and interactive operations by which the designers strive to convince both themselves and their peers of the sense and validity of a particular solution, or of the necessity to respect a particular constraint in relation to the problem.

As Prudhomme says an argumentative situation dealing with the collaborative design of industrial products is a series of defences or attacks on a single or multiple propositions for a solution during evaluation. Authors hypothesise that an argumentative situation is typical of product design. This type of situation allows a team of designers to converge towards a solution, and requires them to negotiate, and so to render explicit their knowledge. Argumentative interactions are typical of design situations where designers must make choices between possible solutions, in order to respond to needs defined by expected performances.

2.2 Negotiation, a key element of the argumentation process for collaborating

Negotiation according to Moeschler (1985) can be seen as constitutive of the verbal interaction: "*without negotiation, the dialogue is transformed into monologue, the function of the interlocutor being reduced to that of a simple receptor of the message*" (p. 176).

Negotiation is also interesting from the perspective of co-construction of knowledge in interaction. This concept, particularly valued by the Vygotsk and Piaget researches, is central in the situated approach wherein « *negotiation is both a means for coordinating perception, action and the environment […] and mechanism for social construction of knowledge by conversation, within 'communities of practice'*» (Baker M. 1994).

According to Baker, negotiations consist basically of sequences of offers that may be accepted or rejected; and two possible strategies are to refine original offers towards agreement, or to keep an offer fixed and to attempt to persuade the other to accept it by argumentation. The negociation is thus the final outcome of the argumentation process.

To summarize, during this dialogue, the actor mediates his knowledge and can change his understanding of the situation leading to the change of the mental maps of the individuals by a convergence of these interpretations. Within the organization, the interaction process allows a collective construction of meaning. These main characteristics of the dialogue remind us the clover design model inspired by the work of Ellis and Wainer (1994). The authors propose a way to model a collaborative situation into three main activities: communication, coordination and production

The link between the observable of the interaction and collaborative activity can be explained as follow. In a dialogue, could be quoted the following activities: communication, coordination and Production.

- Communication as message sending and message receiving process. The communication appears when the receiver sends back a message that could be an idea, a questions… in response to the first message received.
- Coordination means effort of negotiation that should take form of production of argument to attack or defend a proposition.
- Production is the outcome of the two first activities led to a new understanding of the situation. Actors may change their respective mental map by a convergence of the interpretations toward a new vision and representation of the "world".

Thus, within a face to face interaction, collaboration and knowledge sharing can be observed if we quote communication, coordination and Production. However, could we observe same dynamics in online interaction? Could we quote communication, coordination and Production in online interaction among an engineering virtual community of practices?

3 METHODOLOGY

The research has been organized in different steps following an action research paradigm (Coughlan and Coghlan 2002) and a constructivist approach. The researcher (here our first author) is employed by the company as a Knowledge management specialist and participates with the management to improve knowledge exchanges within the Global R&D structure of the company. In a first step, an exploratory study was carried out in the design office and the R&D corporate team over the period of a year. This longitudinal study has been split into two phases: a 6 month period spent with the corporate research team and a six month period spent in the design office. Data were collected through interviews of designers and researchers and several workshops were organized with designers. An extensive diagnosis of the information exchange practices has been realized resulting in changes being implemented that as a result improve information sharing. Preliminary results of this study have been presented in (Fraslin M., Blanco E. et al. 2011). The results of this first step serve as a background for the study presented in this paper.

The second step of the research was to focus on two R&D e-communities identified in the first step. In this paper, we focus on the study done on the online discussion quoted in the respective forum of these two R&D communities of practices. These two communities were using the same wiki technology to support forums. They had a similar objective by the use of the forum which was to improve the way they were sharing technical information and knowledge. One refers here as CAD community focus on CAD tool experience sharing. This community is involving key users of CAD systems, who are in charge of sharing experience, question and continuous improvement of CAD tool configurations and methods. The second Community is involving specialist of Final Element Method (FEM) and simulation analysis in the R&D teams – we refer to this community as CAE. This community is spread in different services but located in the same plant which gives a special configuration of the community. The analysis of the two communities was conducted with two points of view. The first one was to characterize the group as a community; the second was to characterize the activities performed using the platform. In this paper, we'll focus only on the second aspects.

3.1 Characterizing online Interactions

We proceeded to the characterization of the online interactions of the two communities. A systematic platform monitoring based on available indicators of collaborative activity (Gendron, Pourroy et al. 2011), allows for accessing some quantitative data from which collaboration indicators can be derived. Number of posts, number of answers, and number of pages viewed. This quantitative approach provides a global vision of the platform activity. Thus we observed the dynamics of problem solving or information transfer among the groups. From there, we were able to identify and characterize the contribution and the role of the different participants in the groups. The second step of the characterization of online interactions was to select some excerpts of the discussed topics on the platform and to perform a systematic coding of the interactions. The rationale behind the choices of the

Coded sections was based on the intensity of the posts, on the topics and also based on advises of the community moderator.

Table 1: Data collection summary for online interactions coding

	CAD	CAE
Automatic Data collection	x	x
Interviews > 2 hours	x	x
Coding	x	x

In order to qualify each post, we have built a coding scheme which is presented in the next section. Each message has been manually double coded by two distinct coders. The coding was refined until we reached 80% similarity.

3.2 Identifying interaction patterns

Our coding scheme is based on the Rainbow model (Baker, Andriessen et al. 2007). The Rainbow model was initially developed to analyze computer-mediated debates in collaborative learning situations. The analysis was developed to model Chat interactions during knowledge-based debates. This framework has already been reused for modeling design situations by (Prudhomme, Pourroy et al. 2009). The relevance of the model has been shown in this study as far as argumentation appears to be a critical element in the design activity, even if the authors pointed out some limitations of the model and had to adapt it to describe design situations. We found two main limitations of this model in its original form: there were neither proposition or idea items nor question items to describe the actual interactions we were facing. These items are essential in design rationale models like IBIS (Issue Based Information System) (Conklin and Burgess Yakemovic 1991) or DRED (Bracewell and Wallace 2003). Questions have been also highlighted as key elements in the design processes as pointed out by Özgür (2002). Thus we proposed an enriched rainbow model adding "Question" and "Idea" interactions within the task focus activity of the rainbow-coding scheme (figure 1). The coding scheme presented in the figure 1 had been used in this study. A question is an interaction concerned with expressing a problem with respect to a daily workAn idea is an interaction concerned with expressing a proposition of solution with respect to the question raised.

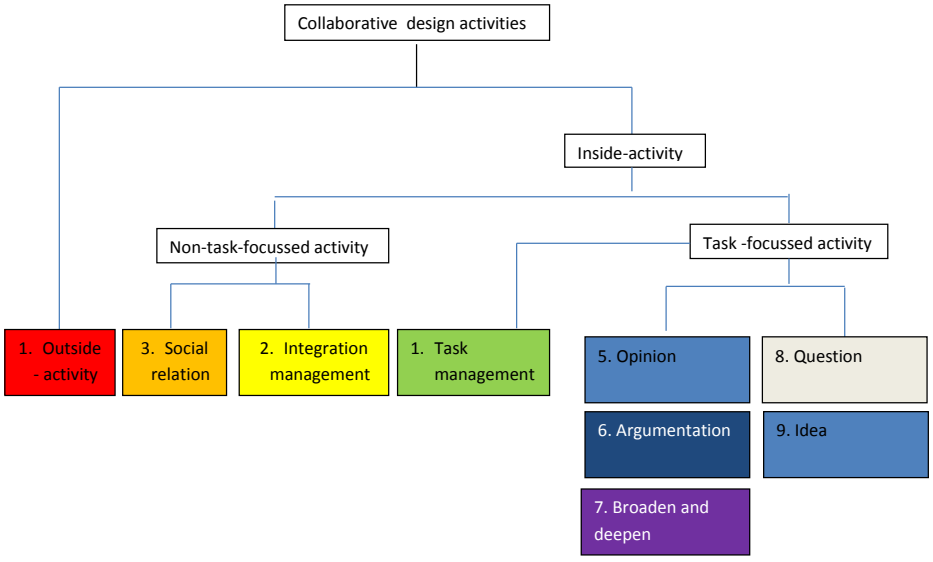

Figure 1: Coding scheme proposed adapted from (Baker, Andriessen et al. 2007)

In the table 2, we crossed the interaction that we could code from corpus analysis and activity required for collaboration and knowlegde sharing viewed in section 2. Interactions are observables that we can track from data. Activities integrate different types of elementary interactions. Thus we can illustrate from observable interaction analysis realised on forum that interactions contribute to different collaborative activities and knowledge sharing. But production (of solution for instance) are the only activity that includes Argumentation and Broaden and Deepen. The analysis will be presented in the next section.

Table 2: From Interactions coded to collaboration activity

Collaboration component	Knowledge sharing Component	Elementary interactions coded
Ellis and Wainer (1994)	From sense Making theory	Rainbow enriched model
Communication	Question-answer	Idea, Opinions, Question, Interaction Management
Coordination	Debate coordination	Task Management, social relation, Interaction Management
Production	Negotiation, Argumentation	Idea, Opinions, Question, Argumentation, Broaden and Deepen

4 INTERACTION ANALYSIS

4.1 CAD community: Patterns of communication show collaboration

The CAD Community is a small group, composed of 14 CAD Key Users spread all over the world leading to a high level of cultural diversity. This community has been intentionally pushed in 2008 by the global engineering management in order to:

- Globally disseminate a common methodology to ensure that the different design offices were using the CAD Software models in the same way and,
- Provide daily support to CAD Software users and improve the CAD Software interface.

This community has a clear Operational objectives. All members are engineers or high level technicians and are generally attracted to software tools. The forum is structured on general Topics; Subjects are created by members inside topics as questions or Problems to discuss. Posts are contributions of each member within a subject.

A first observation based on automatic monitoring of the forum highlights the intensity of communication through the forum. 447 posts structured on 54 subjects. 87% of the posts are in the 3 main topics that covered 62% of the subjects. The average reply rate for each open subject is 6.3, but reaches 11.9 and 11 respectively in the two main topics. In the CAD Forum we have coded all the interactions related to the topic called: “Change management”. This topic represents 72% of the posts. Additionally this topic was also presented as the most representative by the CAD champion. In this topic, there were 27 discussions on which 10 had been closed by an approval from the CAD Champion.

Figure 3 illustrates the type diagram we obtain after coding the exchanges. We have displayed a model of each topic evolution considering the sequence of the interactions among the group. A graphical model of a topic is proposed including the contributor (denoted by a letter) and the place of the post into the sequential chain of contributions. Each rectangle represents a class of interaction (idea, argument, opinion...). The color of each rectangle matches the color of the extended Rainbow categories (figure 1). Within each rectangle there is:

- A letter: which denotes the user that posted the contribution.
- A number: which represents the order of the comment within the sequence of the conversation.
- A class of interaction: which represents the type of comment

Each rectangle is connected to other rectangles by links that represent the relationship(s) between them. The continuous lines connect ideas, arguments, broad and deep, opinions and questions, while the dotted lines connect Task Management Interactions. In this graph we can see that the conversation begins with a question from user "B". This question raises several ideas. The first one (first branch) it is proposed by the user who has posed the question. A "Broaden and Deepen" comment deepens in the idea and an explanation is given. On the contrary, there is a negative argument from the user "E" on the idea proposed by "B". After the negative argumentation "E" gives a new idea. We see that in this branch there is an argumentative process. In the end, this initial idea has been discarded as a solution. In the second branch the user "I" proposes another idea. The user "B" gives negative arguments for this

idea and the idea was eventually discarded. User "H" proposes an idea in the third branch and makes a "Broaden and Deepen" comment, explaining more in depth the idea. Although the user "E" argues in favor of this idea, it is not considered as a solution to the question. In the fourth branch user "E" gives the last idea and "B" agrees with it. We must clarify that the user "B" is the CAD Champion and that he makes the final decision. Around the idea of user "E", a series of task management are made to report the status of development of the idea. As we can see, in this conversation there have been different users who have given different ideas to solve a question. The users have given their opinions and arguments to support or attack one idea or the other. Thus, we can observe an argumentative process between users which means that a collaborative situation has happened. This representation highlights a strong level of collaboration where users cooperate to construct solutions or to raise problems. A question is systematically followed by ideas and arguments denoting an important activity of the forum. This argumentation through online interactions refers to collaboration dynamics of the community. This scheme of interaction relies on problem solving and often leads to proposition of implementation by the CAD Champion.

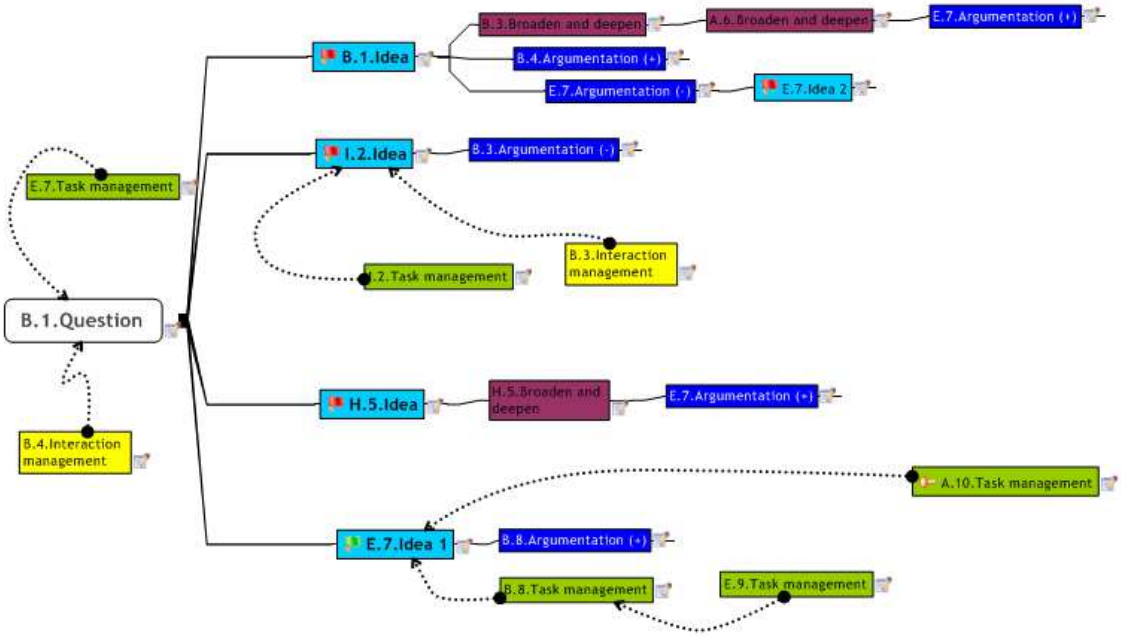

Figure 3 model of a conversation on one subject in the CAD community.

Only 26% of the interactions do not develop argumentative situations. Most of these conversations are subjects where users transfer or exchange information such as feedback on past experiences that do not call for argumentation. If we pay attention to users, two of them (we will call them A and B) are the most active in the discussions within the forum. User A is one of the two IT experts that help the community to solve their technical problems. He gives lots of ideas, arguments and explanations (broadens and deepens category). He is a really important user. User B is the CAD Champion. He encourages people to argue/debate and sets the rubric for these debates. He has a hand in the decision of closing or opening a topic and he posts task management comments too. The full community members except 2 new participants were active on the forum. On each sub-topic, at least 35% of the community was reacting, and if we don't consider the 3 that are not interacting within the forum, this average goes up to 54%. Regarding the timeline, our observations differ from (Barcellini, Détienne et al. 2008) who observed quasi-synchrone exchanges. In our case, the average time of a discussion is 41 days. Our observations and interviews show that emergencies or critical issues are treated with other means than the forum.

4.2 The CAE Forum

The interaction dynamics in the forum is very different than in the CAD community. The whole CAE forum has been coded. 17 discussions were opened, 7 were information transfer and 10 questions asked by a member to the whole community. We noticed that the 10 questions were the monopole of a same member whose comments represented 58% of all forum activity. Only 4 out of the 15 members

were active on the forum. Regarding the 10 questions asked, 8 led to the exchange of at least one idea including one that resulted in argumentation/debate. The 2 other questions did not lead to discussion. In a section of the forum some images were used as comments to support explanation and presentation. Answers were generally a question/answer pattern which transmits information without elaboration of a solution. The average level of reply to a comment is 1.9 which is very low compared to the results of the CAD forum. Anyway the forum had a certain audience as the number of viewed pages is high compared to the level of interaction. On average, the discussions are viewed 36 times. Unfortunately we cannot track who had visualized the discussion. The average time to close a discussion is 64 days.

5 CONCLUSION AND PERSPECTIVES

The coding scheme proposed allows demonstrating that a collaborative platform such as a forum supports asynchronous argumentative activities and thus enhance global collaboration and knowledge sharing in distributed R&D organizations.

During the characterization of the interactions, we have observed that the three activities are supported by a forum:

1. Communication type when members proposed direct answer to specific question.
2. Coordination type when members use the community space to organize work and tasks.
3. Production corresponding to the co-elaboration of decision and the design of a new solution to problems arguing around the proposed solutions.

The following table (table 3) summarizes the characterization of the type of collaborative activities mediated by the forum for the two communities.

For the CAE forum, we have mainly quoted a dynamic of the information transfer leading to few interactions of communication. Forum is not use as collaboration tool. It has to be noted also that the community members are located in the same plant even if in different building and services. They have the possibility to meet each other and to discuss face to face if required. It is widely accepted that ICT will never be a perfect substitute for face-to-face meetings.

This study shows thus that a forum is capable of supporting asynchronous argumentative activities within a remote community as shown by the CAD community and enhances global collaboration and knowledge sharing.

Table 3: type of collaborative activities observed in the two communities.

Collaboration component	**Knowledge sharing Component**	**Elementary interactions coded**	**CAE**	**CAD**
Ellis and Wainer (1994)	Rainbow enriched model	From sense Making theory.	**X**	**X**
Communication	Idea, Opinions, Question, Interaction Management	Question-answer	**X**	**X**
Coordination	Task Management, social relation, Interaction Management	Debate coordination		**X**
Production	Idea, Opinions, Question, Argumentation, Broaden and Deepen	Negotiation, Argumentation		**X**

Besides, the two communities studied have global commonalities: all members are engineers involved in R&D activities of the same product division of the same company. However, they differ in terms of several characteristics particularly one related to the geographical dispersion. Indeed, for the CAD community, the individuals had to communicate mostly through ICT because they are split over the world. This contrasted with CAE community, whose members were located in the same place and therefore met face-to-face on a regular basis. The preference of co-located CoPs to capitalize on the oral discussions that inevitably occur among the group is not a surprising behavior. This observation shows the direct impact of the pair (localization, technology) on the "online" collaboration dynamics of the group. We meet here the claims of Dubé et al (2006) who assume that each VCoPs is unique. The authors produced a comprehensive first-rate article on virtual communities of practice and developed a grid that characterizes existing virtual Communities of Practices and allows one to build a

deep understanding of the communities, from the context of their creation down to various details such as membership profiles. Their typology includes structuring characteristics, stable elements that could be used to describe a VCoP if one wanted to take a picture at a given point in time on which many communities may vary and be compared. The capacity or not to develop full collaborative design online to solve problem has not to be found only in technology purpose but in other characteristics of the community that has to be studied. That is why, further work has to be done in order to make a correlation between the characterization of a Vcop and the form of online interactions developed by the community members online. Other perspectives are with the automatism achievement in the interaction dynamic modeling and visualization. It could be explored different methods of tracking the exchanges within the collaborative platform and evaluate dynamically the level of collaboration. At present, coding is done manually but it remains a strong possibility that in future works opportunities to automate the building of the representation of communities' interaction exchanges.

REFERENCES

Baker, M., J. Andriessen, et al. (2007). "Rainbow: A framework for analysing computer-mediated pedagogical debates." International Journal of Computer-Supported Collaborative Learning 2(2): 315-357.

Baker M. (1994). "A model for negotiation in teaching-learning dialogues." Journal of artificial intelligence in education 5(2): 199-254.

Barcellini, F., F. Détienne, et al. (2008). "A socio-cognitive analysis of online design discussions in an Open source Software community." Interacting with Computers 20: 141-165.

Bracewell, R. H. and K. Wallace (2003). A tool for capturing design rationale. Fourteenth International Conference on Engineering Design (ICED'03), Stockholm, Sweden.

Brassac C. (2000). Intercompréhension et Communiaction. Modèles du discours en confrontation, In A.C. Berthoud L. Mondada (éds): 219-228.

Brassac C. and Grégori N. (2000). "Co-construction de sens en situation de conception d'un outil didactique. ." Studia Romanic Posnaniensia: 55-66.

Conklin, J. and K. Burgess Yakemovic (1991). "A process-oriented approach to design rationale." Human computer interaction 6(3/4): 357-391.

Coughlan, P. and D. Coghlan (2002). "action research for operations management." International Journal of Operations and Production Management 22(2): 220-240.

Crow J. and Smith L. (2005). "Co-teaching in higher education: reflective conversation on shared experience as continued professional development for lecturers and health and social care students. ." Reflective Practice 6(4): 491-506.

Dubé, L., A. Bouris, et al. (2006). "Towards a typology of virtual communities of practice." Interdisciplinary Journal of Information, Knowledge, and Management 1.

Ellis C. and Wainer J. (1994). A conceptual model of groupware ACM conference on computer supported cooperative work.

Fraslin M., Blanco E., et al. (2011). Interface characterization between research central teams and design offices in order to evaluate the knowledge sharing. ICED, Copenhague.

Gardoni, M. and E. Blanco (2003). Harnessing non structured Information in Integrated DesignTeam. International Conference on Engineering Design ICED, Stockholm.

Gardoni, M., E. Blanco, et al. (2005). "MICA-Graph : a tool for managing text and sketches during design processes." Journal of Intelligent Manufacturing 16: 397-407.

Gendron, E., F. Pourroy, et al. (2011). "Towards a structured approach to the definition of indicators for collaborative activities in engineering design,." Journal of Engineering Design Available online: 31 May 2011.

Ioro, J., G. Peschiera, et al. (2011). "actors impacting usage patterns of collaborative tools designed to support global virtual design project networks." Journal of Information Technology in Construction 16: 209-230.

Jung Insung . and Latchem Colin. (2011). A model for e-education: Extended teaching spaces and extended learning spaces. British Journal of Educational technology. 42: 6-18.

Kerbrat-Orecchioni C. (2005). Le discours en interaction, Paris : Armand Colin.

Moeschler J. (1985). Argumentation et conversation : éléments pour une analyse pragmatique du discours, Paris : Hatier-Crédif.

Osterman K. and Kottkamp R. (2004). Reflective practice for educators Thousand Oaks : Corwin Press.
Özgür, E. (2002). Perceiving, Comprehending, and measuring design activity through the questions asked while designing. mechanical Engineering. Stanford, Stanford University. PhD.
Patriotta G. (2003). "Ensemaking on the Shop floor: Narratives of Knowledge in Organizations." Journal of Management Studies 40(2): 349-375.
Paulini, M., P. Murty, et al. (2011). "Understanding collective design communication in open innovation communities." CoDesign: International Journal of CoCreation in Design and the Arts.
Prudhomme G., Pourroy F., et al. (2009). "An empirical study of engineering Knowledge dynamics in a design sitiuation." Journal of design research.
Shigehisa T. (1993). Improving Knowledge Creation Ability through Organizational Learning. ISMICK Proceedings, International Symposium on the Management of Industrial and Corporate Knowledge, UTC Compiègne.
Von Zedtwitz, M., O. Gassmann, et al. (2004). "Organizing global R&D: challenges and dilemmas." Journal of International Management 10(1): 21.